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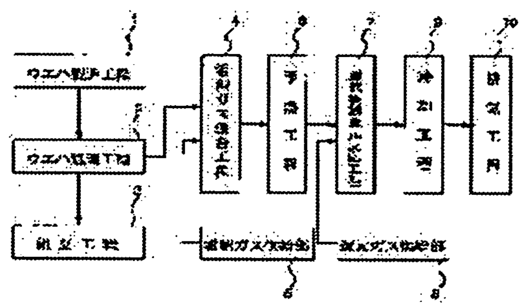
(71)Applicant : HITACHI LTD
HITACHI TOKYO ELECTRON CO LTD
KOKUSAI ELECTRIC CO LTD
TOMOE SHOKAI:KK

(72)Inventor : ARAKI YOSHINORI
UENISHI TOSHIYA
OTSUBO HIROSHI
UCHINO TOSHIYUKI
KANEKO TAKASHI
GOTODA KAZUNORI
MARUFUJI TETSUAKI

(54) MANUFACTURE OF SEMICONDUCTOR, METHOD AND DEVICE OF EXHAUST GAS TREATMENT TO BE USED THEREFOR

(57)Abstract:
PROBLEM TO BE SOLVED: To allow manufacture of a desired semiconductor device by a method wherein in the case of exhausting high-density nitrogen oxides from a semicon ductor manufacturing process, this is reduced below a tolerance value.
SOLUTION: This exhaust gas treatment method includes a dilute gas mixing process 4 mixing the dilute gas to an exhaust gas containing nitric oxides exhausted from a wafer treatment process treating a semiconductor wafer and a selective contact reducing reaction process 7 removing nitrogen oxides in the exhaust gas by selective contact reducing reaction of the diluted exhaust gas. In this case, the diluted exhaust gas is preheated in a preheating process 6 before being introduced into the selective contact reducing reaction process 7 and the exhaust gas exhausted from the selective contact reducing reaction process 7 and being rendered harmless is cooled in a cooling process 9.



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CLAIMS

[Claim(s)]
[Claim 1] The process which manufactures a semi-conductor wafer, and wafer down stream processing which forms an integrated circuit to process the manufactured semi-conductor wafer, The process which mixes the exhaust gas which is the semi-conductor manufacture approach which divides into each semi-conductor pellet the wafer with which the circuit was formed, and is closed in a package of having like an erector, is discharged from said wafer down stream processing, and contains nitrogen oxides, and dilution gas, The semi-conductor manufacture approach characterized by having the damage elimination process which is made to carry out the selection catalytic-reduction reaction of the exhaust gas with which it diluted, and removes nitrogen oxides.
[Claim 2] The flue-gas-treatment approach characterized by having the dilution gas mixing process of making the exhaust gas which is discharged from wafer down stream processing which processes a semi-conductor wafer, and contains nitrogen oxides mixing dilution gas, and the selection catalytic-reduction reaction process of carrying out the selection catalytic-reduction reaction of the exhaust gas with which it diluted, and removing the nitrogen oxides in said exhaust gas.
[Claim 3] The flue-gas-treatment approach characterized by having the preheating process which is the flue-gas-treatment approach according to claim 2, and is beforehand heated before introducing into said selection catalytic-reduction reaction process said exhaust gas with which it diluted, and the cooling process which cools the exhaust gas after the damage elimination discharged from the selection catalytic-reduction reaction process.
[Claim 4] the flue-gas-treatment approach according to claim 2 or 3 -- it is -- said selection catalytic-reaction process -- NH3 etc. -- the flue-gas-treatment approach characterized by introducing reducing gas.
[Claim 5] The flue-gas-treatment approach characterized by processing the exhaust gas from the thermal oxidation processor which is the flue-gas-treatment approach according to claim 2, 3, or 4, and forms the thermal oxidation film in a semi-conductor wafer.
[Claim 6] The flue-gas-treatment approach which is the flue-gas-treatment approach according to claim 2, 3, or 4, and is characterized by performing flue gas treatment only while the thermal oxidation processor of the process which forms the thermal oxidation film in a semi-conductor wafer is operating.
[Claim 7] The dilution gas mixing section which mixes dilution gas to the exhaust gas which is discharged from wafer down stream processing which processes a semi-conductor wafer, and contains nitrogen oxides, The exhaust gas preheating section which heats beforehand the exhaust gas with which it diluted, and the selection catalytic-reduction reaction section which eliminates the nitrogen oxides in said exhaust gas by the selection catalytic-reduction reaction where reducing gas is introduced into the exhaust gas which it preheated, Flue-gas-treatment equipment characterized by having the exhaust air section discharged outside after cooling exhaust gas after nitrogen oxides were removed.
[Claim 8] Flue-gas-treatment equipment which is flue-gas-treatment equipment according to claim 7, and is characterized by heating exhaust gas and reducing gas in temperature of 180-250

degrees C in said selection catalytic-reduction reaction section, and causing said reaction.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In case this invention manufactures a semiconductor device, it relates to the flue-gas-treatment technique of processing the exhaust gas discharged from a production process.
[0002]
[Description of the Prior Art] The production process of semiconductor integrated circuit equipment, i.e., a semiconductor device, has like the erector who divides the process which manufactures a semi-conductor wafer, wafer down stream processing which forms an integrated circuit to process the manufactured semi-conductor wafer, and the wafer with which the circuit was formed, each semi-conductor pellet, i.e., chip, and closes in a package.
[0003] PVD (Physical Vapor Deposition) for forming an insulator layer, electrode wiring, the semi-conductor film, etc. in a wafer front face further at wafer down stream processing, CVD (Chemical VaporDeposition), And the film formation process by means, such as epitaxial growth, the oxidation-treatment process which forms an oxide film in a wafer front face, It has various down stream processing, such as a doping process which adds an impurity atom in a wafer, and etching processing which applies the photoresist film to a wafer front face, and forms a circuit pattern in it.
[0004] The atmospheric oxidation furnace, the high pressure thermal oxidation furnace, the plasma oxidation system, etc. are used for formation of an oxide film on a wafer front face. In an oxidization method, it is dry cleaning O2, a sentiment O2, steam, and H2-O2. Mixed gas etc. is used. The wafer which is a heat-treated object is laid in the interior of the shell which consists of a quartz as indicated by JP,62-4324,A as oxidation-treatment equipment which used steam, for example, the hydrogen which is a combustion fluid, and the oxygen which is a susceptibility-of-substances-to-burn fluid are supplied in tubing, a steam is generated by combustion of hydrogen, and the technique which carries out steam oxidation of the front face of a wafer is known.
[0005] Moreover, the interior is exhausted supplying reactant gas as the above mentioned chemical vapor growth equipment (CVD), into processing tubing with which the wafer was held, as shown, for example in JP,62-245623,A, and there are some which are made to carry out the pyrolysis reaction of the reactant gas, and formed the thin film on the surface of the wafer.
[0006] Furthermore, in order to recover the crystal defect of the layer into which ion was driven and to activate an impurity atom, annealing treatment is made, and about this processing, there are some which are indicated by JP,56-100412,A, for example.
[0007] Thus, supplying raw gas in the container which has the hold room in which a wafer is held, if it is in a semi-conductor production process, this is heated, oxidize a wafer, thin film formation is carried out, or much processings for recovering a crystal defect etc. exist.
[0008]
[Problem(s) to be Solved by the Invention] By the way, this invention person examined the thermal oxidation film formation process. The following is the technique examined by this invention person, and the outline is as follows.

[0009] That is, in order to raise the product yield to a wafer and to form the thermal oxidation film in it, when nitrous oxide (N2 O) gas was used as the raw gas, it pyrolyzed during processing, about 30% of nitrogen oxides were generated, and this needed to be exhausted from down stream processing. comparatively high-concentration NO and NO2 etc. -- also when nitrogen oxides are used as raw gas, it is necessary to discharge the nitrogen oxides of still higher concentration outside from down stream processing. [moreover,]
[0010] Therefore, although it tried to process exhaust gas using the alkali wet adsorption process which passes exhaust gas and removes nitrogen oxides in a water shower, i.e., the scrubber method, it was difficult for below the desired allowed value to remove that is, eliminate nitrogen oxides. It became an important problem how since environmental pollution is caused, exhausting high-concentration nitrogen oxides in the open air as it is can reduce this even to the low concentration below an allowed value on the occasion of the semi-conductor manufacture by the high yield.
[0011] The object of this invention is to enable it [to reduce this below to an allowed value, when high-concentration nitrogen oxides are discharged from a semi-conductor production process, and] to manufacture a desired semiconductor device with the sufficient yield.
[0012] The other objects and the new description will become clear from description and the accompanying drawing of this description along [said] this invention.
[0013]
[Means for Solving the Problem] It will be as follows if the outline of a typical thing is briefly explained among invention indicated in this application.
[0014] Namely, the process at which the semi-conductor manufacture approach of this invention manufactures a semi-conductor wafer, Wafer down stream processing which forms an integrated circuit to process the manufactured semi-conductor wafer, The process which mixes the exhaust gas which is the semi-conductor manufacture approach which divides into each semi-conductor pellet the wafer with which the circuit was formed, and is closed in a package of having like an erector, is discharged from said wafer down stream processing, and contains nitrogen oxides, and dilution gas, It has the damage elimination process which is made to carry out the selection catalytic-reduction reaction of the exhaust gas with which it diluted, and removes nitrogen oxides.
[0015] Moreover, the flue-gas-treatment approach of this invention has the dilution gas mixing process of making the exhaust gas which is discharged from wafer down stream processing which processes a semi-conductor wafer, and contains nitrogen oxides mixing dilution gas, and the selection catalytic-reduction reaction process of carrying out the selection catalytic-reduction reaction of the exhaust gas with which it diluted, and removing the nitrogen oxides in said exhaust gas. Before introducing into a selection catalytic-reduction reaction process the exhaust gas with which it diluted, it preheats it, and the exhaust gas after the damage elimination discharged from the selection catalytic-reduction reaction process is cooled. if it is in a selection catalytic-reaction process -- NH3 etc. -- reducing gas is introduced.
[0016] Furthermore, the dilution gas mixing section which mixes dilution gas to the exhaust gas which the flue-gas-treatment equipment of this invention is discharged from wafer down stream processing which processes a semi-conductor wafer, and contains nitrogen oxides, The exhaust gas preheating section which heats beforehand the exhaust gas with which it diluted, and the selection catalytic-reduction reaction section which eliminates the nitrogen oxides in said exhaust gas by the selection catalytic-reduction reaction where reducing gas is introduced into the exhaust gas which it preheated, After cooling exhaust gas after nitrogen oxides were removed, it has the exhaust air section discharged outside. In the selection catalytic-reduction reaction section, exhaust gas and reducing gas are heated in temperature of 180-250 degrees C, and a selection catalytic-reduction reaction is made.
[0017] It became possible to process a wafer, improving the yield of processing, since the nitrogen oxides contained in the exhaust gas after processing could be eliminated below to the predetermined allowed value and it discharged outside, even if it used the raw gas containing nitrogen oxides for processing of a wafer, if it was in this invention.
[0018]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail based on a drawing.
[0019] Drawing 1 is drawing showing the outline process of the semi-conductor manufacture approach which is the gestalt of 1 operation of this invention, and the erector who divides the wafer production process 1 which manufactures a semi-conductor wafer, the wafer down stream processing 2 which forms an integrated circuit to process the manufactured wafer, and the wafer with which the circuit was formed into each semi-conductor pellet, and closes in a package has 3.
[0020] In the wafer production process 1, it has the single crystal production process which manufactures the ingot of single crystal silicon, the slicing process which cuts this ingot to the wafer which has predetermined thickness. Moreover, in the wafer down stream processing 2, it has doping processes, such as various film formation processes, such as CVD and sputtering, an oxidation-treatment process, and an ion implantation, annealing down stream processing, etching down stream processing, a washing process, etc.
[0021] The exhaust gas in wafer down stream processing which is discharged, for example from a heat treatment process, and contains nitrogen oxides is sent to the dilution gas mixing process 4. The air as dilution gas is supplied to this mixed process 4 from the dilution gas feed zone 5. However, you may make it use the mixed gas of oxygen and inert gas as this dilution gas in addition to air. Here, after a heat process is beforehand sent to 6, for example, the exhaust gas from which it was fully mixed and the concentration of nitrogen oxides became about 1% or less with dilution gas is heated by 380 degrees C - about 400 degrees C, it is sent to the selection catalytic-reduction reaction process 7. In this process, it is the reducing gas feed zone 8 to NH3. Gas is supplied as reducing gas and the nitrogen oxides in exhaust gas are eliminated by the selection catalytic-reduction reaction here.
[0022] By the way, it is NO N2 O2 Decomposing is NO under existence of a catalyst by adding reducing gas, although it is difficult N2 It can be made to return. The catalytic reduction method of NO is low concentration (several 100 ppm) like a combustion gas. Development is made as an object for NO processing, and it is NO and O2 in exhaust gas. The method made to react as selectively [the added reducing gas] as NO when it lives together, and NO and O2 The method made to react with both can be considered, the former is called selective catalytic reduction process, and the latter is called non-selective catalytic reduction process.
[0023] As reducing gas, it is CH4, CO, or H2. Addition obtains a non-choosing catalytic-reduction reaction. It is CH4 as reducing gas. The reaction at the time of adding advances as follows.
[0024]
As CH4+4NO2 ->4 NO+CO2+2H2 OCH4+2O2 ->CO2+2H2 OCH4+4NO->2N2+CO2+2H2 O one side and reducing gas NH3 When it is used, reducing gas is NO and NO2. It reacts selectively and is O2. Being able to select the catalyst which hardly reacts, the addition of reducing gas is NOx. It is good at the receiving equivalent. It is NH3 as reducing gas. NO and NO2 at the time of using The reduction reaction is as follows.
[0025] 3->7-N2 of 6NO+4NH3 ->5N2+6H2 O6NO2+8NH(s)+12H2 O -- NOx for making such a selection catalytic-reduction reaction cause As a reduction catalyst, the catalyst which consists of complex, such as Fe and Mn, is used.
[0026] Although there was a fault which consumes a lot of reducing gas in order to have made the non-choosing catalytic-reduction reaction cause, it turned out for it to be suitable for it to process exhaust gas using a selection catalytic-reduction reaction, if it is in this invention, since there is little amount of the reducing gas used for making a selection catalytic-reduction reaction cause and it ends.
[0027] It is NOx by such reaction. The removed exhaust gas is discharged outside through the exhaust air process 10, after being cooled by the cooling process 9 to near the ordinary temperature.
[0028] It is discharged from wafer down stream processing, and drawing 2 is NOx. It is drawing showing the flue-gas-treatment equipment which processes the included exhaust gas, and the exhaust gas inlet 12 where the exhaust gas which contains in the housing 11 of flue-gas-

treatment equipment the nitrogen oxides discharged from the semi-conductor production process is introduced, and the dilution gas inlet 13 where the mixed gas of the air as dilution gas or oxygen, and inert gas is introduced are formed.

[0029] In order to mix the gas supplied to these inlets 12 and 13 from these inlets, the dilution gas mixing section 14 is connected and nitrogen-oxides concentration is diluted to 1% or less in this dilution gas mixing section 14. The exhaust gas preheating section 15 is connected to this dilution gas mixing section 14, and the temperature of 380 degrees C - 400 degrees C preheats dilution gas here. This exhaust gas preheating section 15 has the tubed casing 16, and while the packing 17 which consists of a grain-like ceramic etc. is poured in into this, the tubed heater 18 is formed in the outside of casing 16. Therefore, even predetermined temperature with a passage preheats the dilution gas which flowed in the exhaust gas preheating section 15 in the clearance formed between packing 17.

[0030] The selection catalytic-reduction reaction section 20 is connected to this exhaust gas preheating section 15, and the exhaust gas which it diluted and preheated flows into this selection catalytic-reduction reaction section 20. Furthermore, the reducing gas supply way 21 is connected to this reaction section 20, and it is NH3 as reducing gas in exhaust gas. It is added. While filling up with the above mentioned catalyst in the casing 22 of this reaction section 20, the heater 23 is formed in the outside of this casing 22, and the temperature in the reaction section 20 is kept at 180 degrees C - 250 degrees C. This heater 23 is constituted by three heaters 23a-23c which became a coiled form, respectively, and can carry out temperature control of the temperature in the reaction section 20 independently about each of the bottom section, an inside flank, and the upside section.

[0031] The cooling section 24 is connected to this reaction section 20, and the exhaust gas with which nitrogen oxides were eliminated below at the allowed value predetermined in the reaction section 20 is introduced into the cooling section 24. The heat exchanger to which the coolant came to circulate through this cooling section 24 is prepared, and exhaust gas is cooled by the temperature of 80 degrees C or less in this cooling section 24. The exhaust air section 25 which consists of a blower, i.e., a blower etc., is connected to this cooling section 24, and the cooled exhaust gas is discharged by this exhaust air section 25 from the exhaust gas outlet 26 to the exterior of housing 11.

[0032] Drawing 3 is NH3 which is reducing gas at exhaust gas. NOx at the time of supplying NH3 in the exhaust gas after damage elimination if it is data in which the experimental result which measured the processing effectiveness of NH3 about various processing temperature is shown and temperature of the exhaust gas of the reaction section 20 is made into 180 degrees C or less A content becomes high and processing effectiveness worsens. On the other hand, it is NH3 when it is made the temperature beyond this. It became clear that processing effectiveness improved.

[0033] On the other hand, when exhaust gas temperature of reaction time is made into 250 degrees C or more, it follows on a temperature rise and is NO2. It became clear that the processing effectiveness of NO fell. It is NH3 to hold reaction temperature at 180-250 degrees C by this experimental result. It was understood that nitrogen oxides can be eliminated below to an allowed value losing residual gas.

[0034] Drawing 4 is drawing showing the case where it is used in order to eliminate the exhaust gas from a thermal oxidation processor [in / for the flue-gas-treatment equipment shown in drawing 2 / wafer down stream processing]. The raw gas supply way 28 for supplying the raw gas which two or more wafers W are held in the processing room in the processing barrel 27 for the thermal oxidation processing installed in the clean room R, and contains nitrogen oxides, such as NO, NO2, or N2 O, in this processing barrel 27 is connected, and the closing motion valve V for opening and closing the duct of this is formed in this raw gas supply way 28 so that it may illustrate. Moreover, this processing barrel 27 is connected to the exhaust gas inlet 12 of flue-gas-treatment equipment by the exhaust gas installation tubing 29.

[0035] If the structure of flue-gas-treatment equipment is the same as that of the case where it is shown in drawing 2 and it is shown in drawing 4 , the same sign is given to the member shown in drawing 2 , and the common member. An exhaust duct 30 is connected to the exhaust gas

outlet 26, and exhaust gas after the damage was eliminated is discharged by the exterior of a clean room R. Thus, NO and NO2 which contain nitrogen oxides in the processing barrel 27 as raw gas By [existing] being and using N2 O, it became possible to perform oxidation treatment of high quality with the sufficient yield.
[0036] Drawing 5 is the block diagram showing the control circuit which controls actuation of the flue-gas-treatment equipment shown in drawing 4 . As dilution gas ****** The temperature of the air supply control section 31 to supply and the exhaust gas preheating section 15 It has the preheating control section 32 to control, the reducing gas supply control section 33 which controls supply of the reducing gas supplied to the reaction section 20, the reaction control section 34 which controls the temperature of the reaction section 20, and the exhaust air control section 35 which controls the exhaust-gas temperature of emission gas after the damage was eliminated. These are connected to the control section 36, respectively.
[0037] The air supply control section 31 has pressure gage 31a which detects the pressure of the air supplied to the dilution gas mixing section 14, and anemometer 31b, these detection signals are sent to a control section 36, and the blower revolution of the exhaust air section 25 is controlled according to these signals. Furthermore, air-shut-off-valve 31c which suspends supply of the air to the dilution gas mixing section 14 in emergency operates with the signal from a control section 36.
[0038] Beforehand, the thermal control section 32 has preheating furnace thermometer 32b which detects the temperature of the casing 16 as heater thermometer 32a which detects the temperature of a heater 18, and a preheating furnace, these detection signals are sent to a control section 36, respectively, and the energization to a heater 18 is controlled by the control section 36 based on these detection signals.
[0039] The reducing gas supply control section 33 has pressure gage 33a which supervises the pressure of reducing gas, and this detecting signal is sent to a control section 36. Moreover, control-of-flow section 33c and N2 which control the flow rate of closing motion valve 33b which opens and closes reducing gas passage to the reducing gas supply control section 33, and reducing gas It has 33d of purge gas control valves which control supply of purge gas, and, as for these, actuation is controlled by the control signal from a control section 36, respectively. N2 Purge gas is NH3 in the reducing gas supply way 21, when equipment breaks down or an emergency shut down is carried out. It is for removing gas, and it does in this way and the insurance of equipment is secured.
[0040] The reaction control section 34 has two or more a total of 34 degrees c of catalyst temperature which detect the temperature of heater thermometer 34a which detects the temperature of a heater 23, reaction cylinder thermometer 34b which detects the temperature of the casing 22 as a reaction cylinder, and a catalyst, respectively, the detection signal from each is sent to a control section 36, and the energization to a heater 23 is controlled according to these detection results.
[0041] The exhaust air control section 35 has blower thermometer 35a which detects the exhaust-gas temperature in the exhaust air section 25, and coolant flow switch 35b which detects whether the coolant is supplied to the heat exchanger of the cooling section 24, and these detecting signals are sent to a control section 36, supervise a system exhaust-gas temperature, and maintain stable operation of a blower.
[0042] Furthermore, a closing motion active signal is sent to the closing motion valve V prepared in the raw gas supply way 28 which the signal which shows that the thermal oxidation processor shown in drawing 4 operated was sent to the control section 36, and was shown in drawing 4 from a control section 36.
[0043] Drawing 6 is a flow chart which shows the procedure of the art in the case of performing automatically flue gas treatment from a thermal oxidation processor using the flue-gas-treatment equipment shown in drawing 4 , and a thermal oxidation processor is NO gas and NO2 from the raw gas supply way 28. The raw gas containing nitrogen oxides, such as gas or N2 O gas, is supplied, and thermal oxidation processing is performed to Wafer W.
[0044] If the command of oxidation-treatment initiation is inputted in step S1 to a thermal oxidation processor as shown in drawing 6 first, when it detects and is set up in unattended

operation mode, whether unattended operation mode is set up at step S2 The signal from degree total of catalyst temperature 34c is incorporated at step S3, and it is distinguished whether it is predetermined temperature to make a selection catalytic-reduction reaction with the optimal exhaust gas in the reaction section 20. When not going up to predetermined temperature, the power which should raise the temperature of a heater 23 is supplied to a heater 23.

[0045] NH3 which will be reducing gas if having become temperature predetermined at step S3 is judged Closing motion valve 33b prepared in the reducing gas supply way 21 is opened by step S4 that it should supply in the reaction section 20, and reducing gas is supplied. Subsequently, at step S5, the closing motion valve V in a thermal oxidation furnace is opened, and raw gas is supplied in the processing barrel 27. Thus, if thermal oxidation processing is made to two or more wafers W and completion of processing is judged at step S6, the closing motion valve V will be closed at step S7, and supply of raw gas will be suspended.

[0046] With this, at step S8, if the timer in a control section 36 operates and cow ton termination of this timer is detected by step S9, by step S10, closing motion valve 33c will be closed and supply of reducing gas will be suspended.

[0047] As a result of using the flue-gas-treatment equipment to illustrate, in exhaust gas after the damage was discharged and eliminated from the exhaust air process 10, NO is 25 ppm or less and NO2. 3 ppm or less and NH3 It was set to 25 ppm or less, and each residual component was eliminated below at the allowed value.

[0048] If it is in the equipment shown in drawing 4 , since blowdown of the nitrogen oxides from thermal oxidation down stream processing which is a semi-conductor production process will be interlocked with, flue-gas-treatment equipment will be operated automatically, it will be made to correspond to a halt of thermal oxidation down stream processing and flue-gas-treatment equipment will be suspended automatically, it is prevented certainly that flue-gas-treatment equipment operates independently, and an operation failure is prevented certainly. Furthermore, while the semi-conductor production process is operating and being able to save the amount used, such as reducing gas, since reducing gas will be supplied to flue-gas-treatment equipment, a safety operation of equipment is attained. Moreover, since flue-gas-treatment equipment operates only while the semi-conductor production process is operating, it becomes unnecessary to operate the blower of the heater in this equipment or the exhaust air section, and economization of power can be realized.

[0049] As mentioned above, although invention made by this invention person was concretely explained based on the gestalt of operation, it cannot be overemphasized that it can change variously in the range which this invention is not limited to the gestalt of said operation, and does not deviate from the summary.

[0050] For example, although he is trying for drawing 4 to process the exhaust gas from the thermal oxidation furnace which is semiconductor fabrication machines and equipment, this invention is applicable in order to eliminate the exhaust gas from an annealer. Furthermore, if it is exhaust gas from semi-conductor wafer down stream processing which nitrogen oxides generate in addition to these, it can process with any processes thru/or the exhaust gas from equipment.

[0051]

[Effect of the Invention] It will be as follows if the effectiveness acquired by the typical thing among invention indicated in this application is explained briefly.

[0052] (1) The raw gas which contains nitrogen oxides on the occasion of processing of . semi-conductor wafer can be used, and it became possible to process high quality with the sufficient yield.

[0053] (2) It became possible to manufacture a semi-conductor efficiently, processing of a semi-conductor wafer in case generating of nitrogen oxides becomes unescapable having been attained, and preventing air pollution and environmental destruction, since it discharged outside after processing the exhaust gas containing the nitrogen oxides generated from the process which processes . semi-conductor wafer and eliminating nitrogen oxides.

[0054] (3) A damage can be eliminated below to an allowed value and the nitrogen oxides in the exhaust gas which occurs from the production process of semi-conductor wafers, such as .

thermal oxidation processor and an annealing processor, can be purified in clarification gas.
[0055] (4) Since flue-gas-treatment equipment can be installed near each processors, such as thermal oxidation down stream processing which constitutes . semi-conductor production process, a damage can be eliminated about each equipment which nitrogen oxides generate.
[0056] (5) Since a damage can be eliminated on each point about the equipment which ., therefore nitrogen oxides generate, it is prevented that exhaust gas other than nitrogen oxides mixes in flue-gas-treatment equipment, and it can attain the reinforcement of a catalyst.
[0057] (6) Effectiveness, such as improvement in the safety of flue-gas-treatment equipment and power economization, is acquired reducing the amount of the reducing gas used, since . flue-gas-treatment equipment operates only while the semiconductor fabrication machines and equipment which are the sources of release of exhaust gas are operating.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Field of the Invention] In case this invention manufactures a semiconductor device, it relates to the flue-gas-treatment technique of processing the exhaust gas discharged from a production process.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The production process of semiconductor integrated circuit equipment, i.e., a semiconductor device, has like the erector who divides the process which manufactures a semi-conductor wafer, wafer down stream processing which forms an integrated circuit to process the manufactured semi-conductor wafer, and the wafer with which the circuit was formed, each semi-conductor pellet, i.e., chip, and closes in a package.
[0003] PVD (Physical Vapor Deposition) for forming an insulator layer, electrode wiring, the semi-conductor film, etc. in a wafer front face further at wafer down stream processing, and CVD (Chemical VaporDeposition) -- and It has various down stream processing, such as a film formation process by means, such as epitaxial growth, an oxidation-treatment process which forms an oxide film in a wafer front face, a doping process which adds an impurity atom in a wafer, and etching processing which applies the photoresist film to a wafer front face, and forms a circuit pattern in it.
[0004] The atmospheric oxidation furnace, the high pressure thermal oxidation furnace, the plasma oxidation system, etc. are used for formation of an oxide film on a wafer front face. In an oxidization method, it is dry cleaning O2, a sentiment O2, steam, and H2-O2. Mixed gas etc. is used. The wafer which is a heat-treated object is laid in the interior of the shell which consists of a quartz as indicated by JP,62-4324,A as oxidation-treatment equipment which used steam, for example, the hydrogen which is a combustion fluid, and the oxygen which is a susceptibility-of-substances-to-burn fluid are supplied in tubing, a steam is generated by combustion of hydrogen, and the technique which carries out steam oxidation of the front face of a wafer is known.
[0005] Moreover, the interior is exhausted supplying reactant gas as the above mentioned chemical vapor growth equipment (CVD), into processing tubing with which the wafer was held, as shown, for example in JP,62-245623,A, and there are some which are made to carry out the pyrolysis reaction of the reactant gas, and formed the thin film on the surface of the wafer.
[0006] Furthermore, in order to recover the crystal defect of the layer into which ion was driven and to activate an impurity atom, annealing treatment is made, and about this processing, there are some which are indicated by JP,56-100412,A, for example.
[0007] Thus, supplying raw gas in the container which has the hold room in which a wafer is held, if it is in a semi-conductor production process, this is heated, oxidize a wafer, thin film formation is carried out, or much processings for recovering a crystal defect etc. exist.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] It will be as follows if the effectiveness acquired by the typical thing among invention indicated in this application is explained briefly.
[0052] (1) The raw gas which contains nitrogen oxides on the occasion of processing of . semi-conductor wafer can be used, and it became possible to process high quality with the sufficient yield.
[0053] (2) It became possible to manufacture a semi-conductor efficiently, processing of a semi-conductor wafer in case generating of nitrogen oxides becomes unescapable having been attained, and preventing air pollution and environmental destruction, since it discharged outside after processing the exhaust gas containing the nitrogen oxides generated from the process which processes . semi-conductor wafer and eliminating nitrogen oxides.
[0054] (3) A damage can be eliminated below to an allowed value and the nitrogen oxides in the exhaust gas which occurs from the production process of semi-conductor wafers, such as . thermal oxidation processor and an annealing processor, can be purified in clarification gas.
[0055] (4) Since flue-gas-treatment equipment can be installed near each processors, such as thermal oxidation down stream processing which constitutes . semi-conductor production process, a damage can be eliminated about each equipment which nitrogen oxides generate.
[0056] (5) Since a damage can be eliminated on each point about the equipment which ., therefore nitrogen oxides generate, it is prevented that exhaust gas other than nitrogen oxides mixes in flue-gas-treatment equipment, and it can attain the reinforcement of a catalyst.
[0057] (6) Effectiveness, such as improvement in the safety of flue-gas-treatment equipment and power economization, is acquired reducing the amount of the reducing gas used, since . flue-gas-treatment equipment operates only while the semiconductor fabrication machines and equipment which are the sources of release of exhaust gas are operating.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, this invention person examined the thermal oxidation film formation process. The following is the technique examined by this invention person, and the outline is as follows.
[0009] That is, in order to raise the product yield to a wafer and to form the thermal oxidation film in it, when nitrous oxide (N2 O) gas was used as the raw gas, it pyrolyzed during processing, about 30% of nitrogen oxides were generated, and this needed to be exhausted from down stream processing. comparatively high-concentration NO and NO2 etc. -- also when nitrogen oxides are used as raw gas, it is necessary to discharge the nitrogen oxides of still higher concentration outside from down stream processing. [moreover,]
[0010] Therefore, although it tried to process exhaust gas using the alkali wet adsorption process which passes exhaust gas and removes nitrogen oxides in a water shower, i.e., the scrubber method, it was difficult for below the desired allowed value to remove that is, eliminate nitrogen oxides. It became an important problem how since environmental pollution is caused, exhausting high-concentration nitrogen oxides in the open air as it is can reduce this even to the low concentration below an allowed value on the occasion of the semi-conductor manufacture by the high yield.
[0011] The object of this invention is to enable it [to reduce this below to an allowed value, when high-concentration nitrogen oxides are discharged from a semi-conductor production process, and] to manufacture a desired semiconductor device with the sufficient yield.
[0012] The other objects and the new description will become clear from description and the accompanying drawing of this description along [said] this invention.

[Translation done.]

MEANS

[Means for Solving the Problem] It will be as follows if the outline of a typical thing is briefly explained among invention indicated in this application.
[0014] Namely, the process at which the semi-conductor manufacture approach of this invention manufactures a semi-conductor wafer, Wafer down stream processing which forms an integrated circuit to process the manufactured semi-conductor wafer, The process which mixes the exhaust gas which is the semi-conductor manufacture approach which divides into each semi-conductor pellet the wafer with which the circuit was formed, and is closed in a package of having like an erector, is discharged from said wafer down stream processing, and contains nitrogen oxides, and dilution gas, It has the damage elimination process which is made to carry out the selection catalytic-reduction reaction of the exhaust gas with which it diluted, and removes nitrogen oxides.
[0015] Moreover, the flue-gas-treatment approach of this invention has the dilution gas mixing process of making the exhaust gas which is discharged from wafer down stream processing which processes a semi-conductor wafer, and contains nitrogen oxides mixing dilution gas, and the selection catalytic-reduction reaction process of carrying out the selection catalytic-reduction reaction of the exhaust gas with which it diluted, and removing the nitrogen oxides in said exhaust gas. Before introducing into a selection catalytic-reduction reaction process the exhaust gas with which it diluted, it preheats it, and the exhaust gas after the damage elimination discharged from the selection catalytic-reduction reaction process is cooled. if it is in a selection catalytic-reaction process -- NH3 etc. -- reducing gas is introduced.
[0016] Furthermore, the dilution gas mixing section which mixes dilution gas to the exhaust gas which the flue-gas-treatment equipment of this invention is discharged from wafer down stream processing which processes a semi-conductor wafer, and contains nitrogen oxides, The exhaust gas preheating section which heats beforehand the exhaust gas with which it diluted, and the selection catalytic-reduction reaction section which eliminates the nitrogen oxides in said exhaust gas by the selection catalytic-reduction reaction where reducing gas is introduced into the exhaust gas which it preheated, After cooling exhaust gas after nitrogen oxides were removed, it has the exhaust air section discharged outside. In the selection catalytic-reduction reaction section, exhaust gas and reducing gas are heated in temperature of 180-250 degrees C, and a selection catalytic-reduction reaction is made.
[0017] It became possible to process a wafer, improving the yield of processing, since the nitrogen oxides contained in the exhaust gas after processing could be eliminated below to the predetermined allowed value and it discharged outside, even if it used the raw gas containing nitrogen oxides for processing of a wafer, if it was in this invention.
[0018]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail based on a drawing.
[0019] Drawing 1 is drawing showing the outline process of the semi-conductor manufacture approach which is the gestalt of 1 operation of this invention, and the erector who divides the wafer production process 1 which manufactures a semi-conductor wafer, the wafer down stream processing 2 which forms an integrated circuit to process the manufactured wafer, and the wafer

with which the circuit was formed into each semi-conductor pellet, and closes in a package has 3.

[0020] In the wafer production process 1, it has the single crystal production process which manufactures the ingot of single crystal silicon, the slicing process which cuts this ingot to the wafer which has predetermined thickness. Moreover, in the wafer down stream processing 2, it has doping processes, such as various film formation processes, such as CVD and sputtering, an oxidation-treatment process, and an ion implantation, annealing down stream processing, etching down stream processing, a washing process, etc.

[0021] The exhaust gas in wafer down stream processing which is discharged, for example from a heat treatment process, and contains nitrogen oxides is sent to the dilution gas mixing process 4. The air as dilution gas is supplied to this mixed process 4 from the dilution gas feed zone 5. However, you may make it use the mixed gas of oxygen and inert gas as this dilution gas in addition to air. Here, after a heat process is beforehand sent to 6, for example, the exhaust gas from which it was fully mixed and the concentration of nitrogen oxides became about 1% or less with dilution gas is heated by 380 degrees C - about 400 degrees C, it is sent to the selection catalytic-reduction reaction process 7. In this process, it is the reducing gas feed zone 8 to NH3. Gas is supplied as reducing gas and the nitrogen oxides in exhaust gas are eliminated by the selection catalytic-reduction reaction here.

[0022] By the way, it is NO N2 O2 Decomposing is NO under existence of a catalyst by adding reducing gas, although it is difficult N2 It can be made to return. The catalytic reduction method of NO is low concentration (several 100 ppm) like a combustion gas. Development is made as an object for NO processing, and it is NO and O2 in exhaust gas. The method made to react as selectively [the added reducing gas] as NO when it lives together, and NO and O2 The method made to react with both can be considered, the former is called selective catalytic reduction process, and the latter is called non-selective catalytic reduction process.

[0023] As reducing gas, it is CH4, CO, or H2. Addition obtains a non-choosing catalytic-reduction reaction. It is CH4 as reducing gas. The reaction at the time of adding advances as follows.

[0024]

As CH4+4NO2 ->4 NO+CO2+2H2 OCH4+2O2 ->CO2+2H2 OCH4+4NO->2N2+CO2+2H2 O one side and reducing gas NH3 When it is used, reducing gas is NO and NO2. It reacts selectively and is O2. Being able to select the catalyst which hardly reacts, the addition of reducing gas is NOx. It is good at the receiving equivalent. It is NH3 as reducing gas. NO and NO2 at the time of using The reduction reaction is as follows.

[0025] 3->7-N2 of 6NO+4NH3 ->5N2+6H2 O6NO2+8NH(s)+12H2 O -- NOx for making such a selection catalytic-reduction reaction cause As a reduction catalyst, the catalyst which consists of complex, such as Fe and Mn, is used.

[0026] Although there was a fault which consumes a lot of reducing gas in order to have made the non-choosing catalytic-reduction reaction cause, it turned out for it to be suitable for it to process exhaust gas using a selection catalytic-reduction reaction, if it is in this invention, since there is little amount of the reducing gas used for making a selection catalytic-reduction reaction cause and it ends.

[0027] It is NOx by such reaction. The removed exhaust gas is discharged outside through the exhaust air process 10, after being cooled by the cooling process 9 to near the ordinary temperature.

[0028] It is discharged from wafer down stream processing, and drawing 2 is NOx. It is drawing showing the flue-gas-treatment equipment which processes the included exhaust gas, and the exhaust gas inlet 12 where the exhaust gas which contains in the housing 11 of flue-gas-treatment equipment the nitrogen oxides discharged from the semi-conductor production process is introduced, and the dilution gas inlet 13 where the mixed gas of the air as dilution gas or oxygen, and inert gas is introduced are formed.

[0029] In order to mix the gas supplied to these inlets 12 and 13 from these inlets, the dilution gas mixing section 14 is connected and nitrogen-oxides concentration is diluted to 1% or less in this dilution gas mixing section 14. The exhaust gas preheating section 15 is connected to this

dilution gas mixing section 14, and the temperature of 380 degrees C - 400 degrees C preheats dilution gas here. This exhaust gas preheating section 15 has the tubed casing 16, and while the packing 17 which consists of a grain-like ceramic etc. is poured in into this, the tubed heater 18 is formed in the outside of casing 16. Therefore, even predetermined temperature with a passage preheats the dilution gas which flowed in the exhaust gas preheating section 15 in the clearance formed between packing 17.

[0030] The selection catalytic-reduction reaction section 20 is connected to this exhaust gas preheating section 15, and the exhaust gas which it diluted and preheated flows into this selection catalytic-reduction reaction section 20. Furthermore, the reducing gas supply way 21 is connected to this reaction section 20, and it is NH3 as reducing gas in exhaust gas. It is added. While filling up with the above mentioned catalyst in the casing 22 of this reaction section 20, the heater 23 is formed in the outside of this casing 22, and the temperature in the reaction section 20 is kept at 180 degrees C - 250 degrees C. This heater 23 is constituted by three heaters 23a-23c which became a coiled form, respectively, and can carry out temperature control of the temperature in the reaction section 20 independently about each of the bottom section, an inside flank, and the upside section.

[0031] The cooling section 24 is connected to this reaction section 20, and the exhaust gas with which nitrogen oxides were eliminated below at the allowed value predetermined in the reaction section 20 is introduced into the cooling section 24. The heat exchanger to which the coolant came to circulate through this cooling section 24 is prepared, and exhaust gas is cooled by the temperature of 80 degrees C or less in this cooling section 24. The exhaust air section 25 which consists of a blower, i.e., a blower etc., is connected to this cooling section 24, and the cooled exhaust gas is discharged by this exhaust air section 25 from the exhaust gas outlet 26 to the exterior of housing 11.

[0032] Drawing 3 is NH3 which is reducing gas at exhaust gas. NOx at the time of supplying NH3 in the exhaust gas after damage elimination if it is data in which the experimental result which measured the processing effectiveness of NH3 about various processing temperature is shown and temperature of the exhaust gas of the reaction section 20 is made into 180 degrees C or less A content becomes high and processing effectiveness worsens. On the other hand, it is NH3 when it is made the temperature beyond this. It became clear that processing effectiveness improved.

[0033] On the other hand, when exhaust gas temperature of reaction time is made into 250 degrees C or more, it follows on a temperature rise and is NO2. It became clear that the processing effectiveness of NO fell. It is NH3 to hold reaction temperature at 180-250 degrees C by this experimental result. It was understood that nitrogen oxides can be eliminated below to an allowed value losing residual gas.

[0034] Drawing 4 is drawing showing the case where it is used in order to eliminate the exhaust gas from a thermal oxidation processor [in / for the flue-gas-treatment equipment shown in drawing 2 / wafer down stream processing]. The raw gas supply way 28 for supplying the raw gas which two or more wafers W are held in the processing room in the processing barrel 27 for the thermal oxidation processing installed in the clean room R, and contains nitrogen oxides, such as NO, NO2, or N2 O, in this processing barrel 27 is connected, and the closing motion valve V for opening and closing the duct of this is formed in this raw gas supply way 28 so that it may illustrate. Moreover, this processing barrel 27 is connected to the exhaust gas inlet 12 of flue-gas-treatment equipment by the exhaust gas installation tubing 29.

[0035] If the structure of flue-gas-treatment equipment is the same as that of the case where it is shown in drawing 2 and it is shown in drawing 4 , the same sign is given to the member shown in drawing 2 , and the common member. An exhaust duct 30 is connected to the exhaust gas outlet 26, and exhaust gas after the damage was eliminated is discharged by the exterior of a clean room R. Thus, NO and NO2 which contain nitrogen oxides in the processing barrel 27 as raw gas By [existing] being and using N2 O, it became possible to perform oxidation treatment of high quality with the sufficient yield.

[0036] Drawing 5 is the block diagram showing the control circuit which controls actuation of the flue-gas-treatment equipment shown in drawing 4 . As dilution gas ****** The temperature of

the air supply control section 31 to supply and the exhaust gas preheating section 15 It has the preheating control section 32 to control, the reducing gas supply control section 33 which controls supply of the reducing gas supplied to the reaction section 20, the reaction control section 34 which controls the temperature of the reaction section 20, and the exhaust air control section 35 which controls the exhaust-gas temperature of emission gas after the damage was eliminated. These are connected to the control section 36, respectively.
[0037] The air supply control section 31 has pressure gage 31a which detects the pressure of the air supplied to the dilution gas mixing section 14, and anemometer 31b, these detection signals are sent to a control section 36, and the blower revolution of the exhaust air section 25 is controlled according to these signals. Furthermore, air-shut-off-valve 31c which suspends supply of the air to the dilution gas mixing section 14 in emergency operates with the signal from a control section 36.
[0038] Beforehand, the thermal control section 32 has preheating furnace thermometer 32b which detects the temperature of the casing 16 as heater thermometer 32a which detects the temperature of a heater 18, and a preheating furnace, these detection signals are sent to a control section 36, respectively, and the energization to a heater 18 is controlled by the control section 36 based on these detection signals.
[0039] The reducing gas supply control section 33 has pressure gage 33a which supervises the pressure of reducing gas, and this detecting signal is sent to a control section 36. Moreover, control-of-flow section 33c and N2 which control the flow rate of closing motion valve 33b which opens and closes reducing gas passage to the reducing gas supply control section 33, and reducing gas It has 33d of purge gas control valves which control supply of purge gas, and, as for these, actuation is controlled by the control signal from a control section 36, respectively. N2 Purge gas is NH3 in the reducing gas supply way 21, when equipment breaks down or an emergency shut down is carried out. It is for removing gas, and it does in this way and the insurance of equipment is secured.
[0040] The reaction control section 34 has two or more a total of 34 degrees c of catalyst temperature which detect the temperature of heater thermometer 34a which detects the temperature of a heater 23, reaction cylinder thermometer 34b which detects the temperature of the casing 22 as a reaction cylinder, and a catalyst, respectively, the detection signal from each is sent to a control section 36, and the energization to a heater 23 is controlled according to these detection results.
[0041] The exhaust air control section 35 has blower thermometer 35a which detects the exhaust-gas temperature in the exhaust air section 25, and coolant flow switch 35b which detects whether the coolant is supplied to the heat exchanger of the cooling section 24, and these detecting signals are sent to a control section 36, supervise a system exhaust-gas temperature, and maintain stable operation of a blower.
[0042] Furthermore, a closing motion active signal is sent to the closing motion valve V prepared in the raw gas supply way 28 which the signal which shows that the thermal oxidation processor shown in drawing 4 operated was sent to the control section 36, and was shown in drawing 4 from a control section 36.
[0043] Drawing 6 is a flow chart which shows the procedure of the art in the case of performing automatically flue gas treatment from a thermal oxidation processor using the flue-gas-treatment equipment shown in drawing 4 , and a thermal oxidation processor is NO gas and NO2 from the raw gas supply way 28. The raw gas containing nitrogen oxides, such as gas or N2 O gas, is supplied, and thermal oxidation processing is performed to Wafer W.
[0044] If the command of oxidation-treatment initiation is inputted in step S1 to a thermal oxidation processor as shown in drawing 6 first, when it detects and is set up in unattended operation mode, whether unattended operation mode is set up at step S2 The signal from degree total of catalyst temperature 34c is incorporated at step S3, and it is distinguished whether it is predetermined temperature to make a selection catalytic-reduction reaction with the optimal exhaust gas in the reaction section 20. When not going up to predetermined temperature, the power which should raise the temperature of a heater 23 is supplied to a heater 23.
[0045] NH3 which will be reducing gas if having become temperature predetermined at step S3 is

judged Closing motion valve 33b prepared in the reducing gas supply way 21 is opened by step S4 that it should supply in the reaction section 20, and reducing gas is supplied. Subsequently, at step S5, the closing motion valve V in a thermal oxidation furnace is opened, and raw gas is supplied in the processing barrel 27. Thus, if thermal oxidation processing is made to two or more wafers W and completion of processing is judged at step S6, the closing motion valve V will be closed at step S7, and supply of raw gas will be suspended.

[0046] With this, at step S8, if the timer in a control section 36 operates and cow ton termination of this timer is detected by step S9, by step S10, closing motion valve 33c will be closed and supply of reducing gas will be suspended.

[0047] As a result of using the flue-gas-treatment equipment to illustrate, in exhaust gas after the damage was discharged and eliminated from the exhaust air process 10, NO is 25 ppm or less and NO2. 3 ppm or less and NH3 It was set to 25 ppm or less, and each residual component was eliminated below at the allowed value.

[0048] If it is in the equipment shown in drawing 4 , since blowdown of the nitrogen oxides from thermal oxidation down stream processing which is a semi-conductor production process will be interlocked with, flue-gas-treatment equipment will be operated automatically, it will be made to correspond to a halt of thermal oxidation down stream processing and flue-gas-treatment equipment will be suspended automatically, it is prevented certainly that flue-gas-treatment equipment operates independently, and an operation failure is prevented certainly. Furthermore, while the semi-conductor production process is operating and being able to save the amount used, such as reducing gas, since reducing gas will be supplied to flue-gas-treatment equipment, a safety operation of equipment is attained. Moreover, since flue-gas-treatment equipment operates only while the semi-conductor production process is operating, it becomes unnecessary to operate the blower of the heater in this equipment or the exhaust air section, and economization of power can be realized.

[0049] As mentioned above, although invention made by this invention person was concretely explained based on the gestalt of operation, it cannot be overemphasized that it can change variously in the range which this invention is not limited to the gestalt of said operation, and does not deviate from the summary.

[0050] For example, although he is trying for drawing 4 to process the exhaust gas from the thermal oxidation furnace which is semiconductor fabrication machines and equipment, this invention is applicable in order to eliminate the exhaust gas from an annealer. Furthermore, if it is exhaust gas from semi-conductor wafer down stream processing which nitrogen oxides generate in addition to these, it can process with any processes thru/or the exhaust gas from equipment.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the production process of the semiconductor device manufacture approach which is the gestalt of 1 operation of this invention.
[Drawing 2] It is the sectional view showing the flue-gas-treatment equipment which materialized the flue-gas-treatment approach which is the gestalt of 1 operation of this invention.
[Drawing 3] It is experimental data in which the relation between whenever [in the selection catalytic-reduction reaction section / furnace temperature], and the processing effectiveness of gas reaction on the staff is shown.
[Drawing 4] It is the sectional view showing the flue-gas-treatment equipment for eliminating the nitrogen oxides from the thermal oxidation processor used for the semi-conductor manufacture approach.
[Drawing 5] It is the block diagram showing the control circuit for controlling actuation of the flue-gas-treatment equipment shown in drawing 4 .
[Drawing 6] It is the flow chart which shows the flue-gas-treatment procedure in the flue-gas-treatment equipment shown in drawing 4 .
[Description of Notations]
1 Wafer Production Process
2 Wafer Down Stream Processing
3 Like Erector
4 Dilution Gas Mixing Process
5 Dilution Gas Feed Zone
6 Heat Process is Beforehand.
7 Selection Catalytic-Reduction Reaction Process
8 Reducing Gas Feed Zone
9 Cooling Process
10 Exhaust Air Process
11 Housing
12 Exhaust Gas Inlet
13 Dilution Gas Inlet
14 Dilution Gas Mixing Section
15 Exhaust Gas Preheating Section
16 Casing
17 Packing
18 Heater
20 Selection Catalytic-Reduction Reaction Section
21 Reducing Gas Supply Way
22 Casing
23 Heater
24 Cooling Section
25 Exhaust Air Section

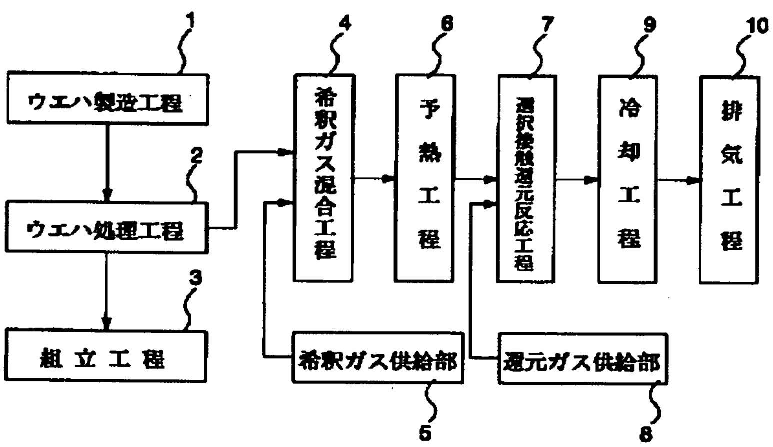
26 Exhaust Gas Outlet
27 Processing Barrel
28 Raw Gas Supply Way
29 Exhaust Gas Installation Tubing
30 Exhaust Duct
31 Air Supply Control Section
32 It is Thermal Control Section Beforehand.
33 Reducing Gas Supply Control Section
34 Reaction Control Section
35 Exhaust Air Control Section
36 Control Section

[Translation done.]

DRAWINGS

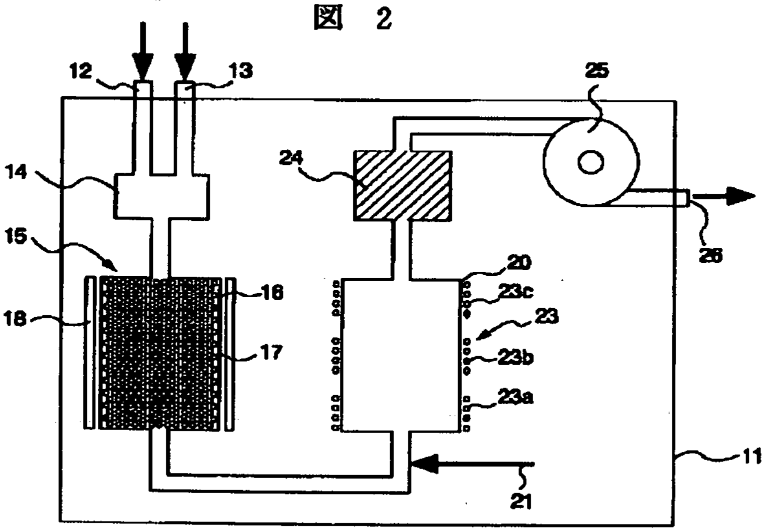
[Drawing 1]

図 1



[Drawing 2]

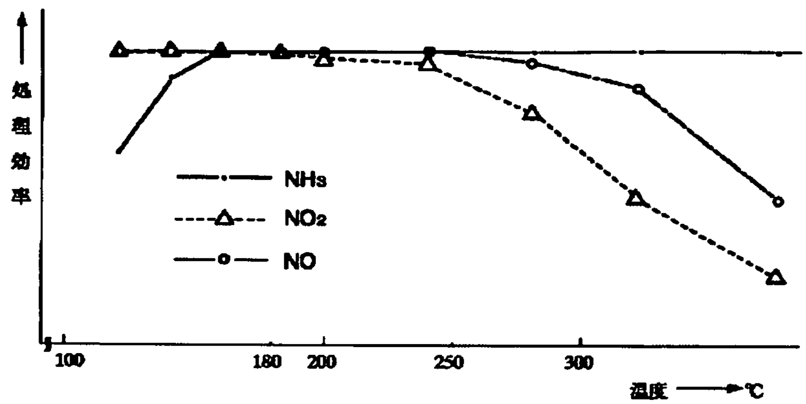
図 2



14 ：希釈ガス混合部　20 ：選択接触還元反応部
15 ：排ガス予熱部　24 ：冷却部
17 ：充填物　25 ：排気部

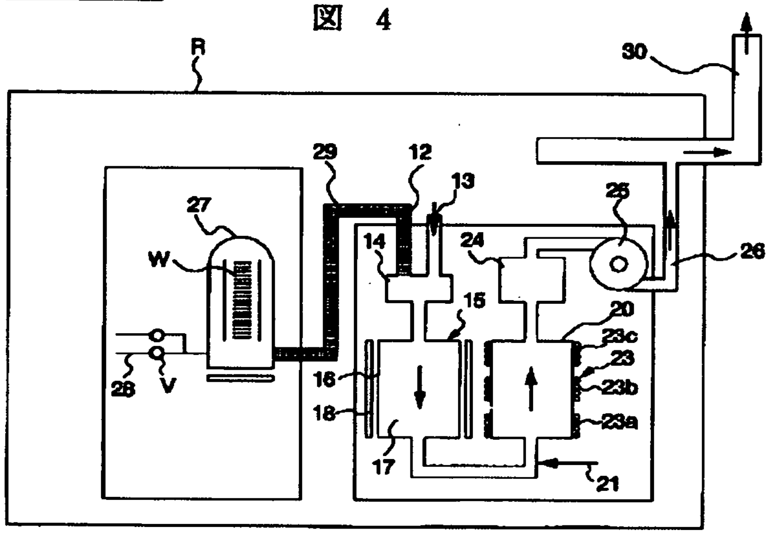
[Drawing 3]

図 3



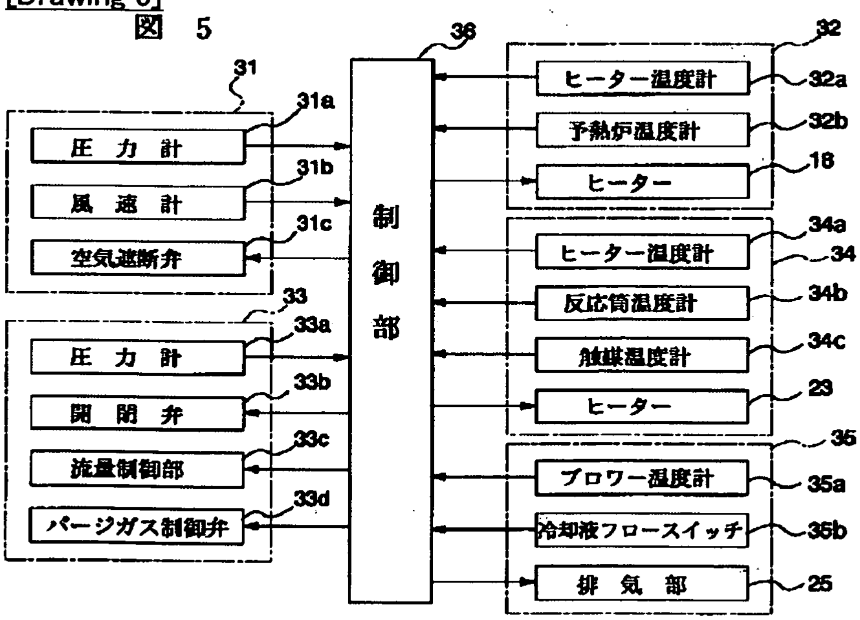
[Drawing 4]

図 4



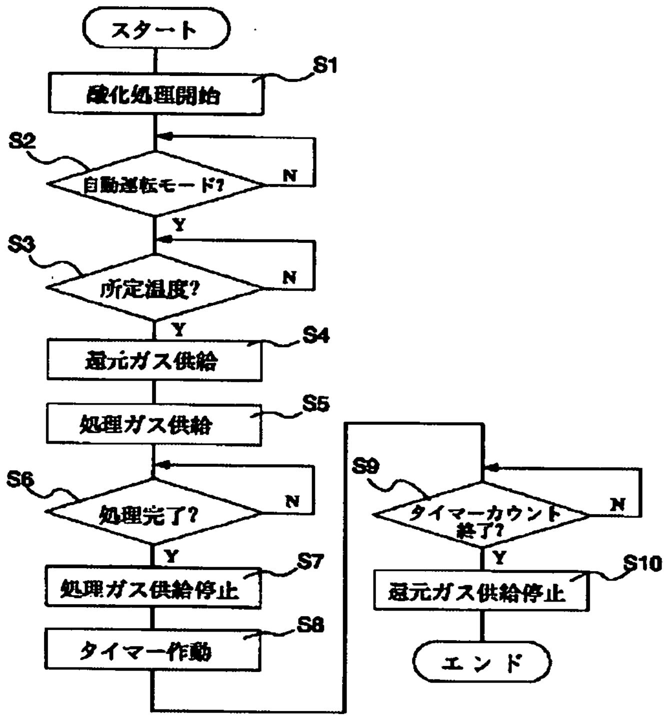
[Drawing 5]

図 5



[Drawing 6]

図 6



[Translation done.]

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H01L 29/78					
			H01L 29/78	301 D	

審査請求　未請求　請求項の数１　ＯＬ　（全５頁）

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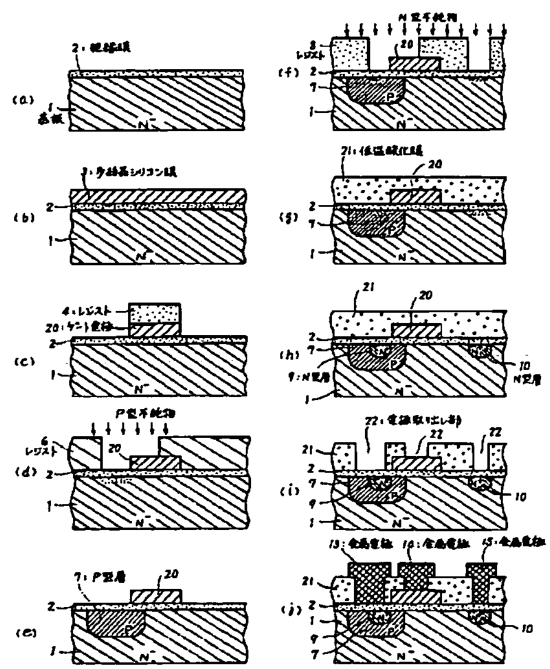
(22)出願日　平成７年(1995)２月２日

(71)出願人　000006507
横河電機株式会社
東京都武蔵野市中町２丁目９番32号
(72)発明者　石黒　宏
東京都武蔵野市中町２丁目９番32号　横河電機株式会社内
(72)発明者　津波古　充吉
東京都武蔵野市中町２丁目９番32号　横河電機株式会社内
(72)発明者　柏田　昌之
東京都武蔵野市中町２丁目９番32号　横河電機株式会社内
(74)代理人　弁理士　渡辺　正康　（外１名）

(54)【発明の名称】　半導体集積回路の製造方法

(57)【要約】　（修正有）
【目的】　最終的に作られるＭＯＳ　ＦＥＴの構造を変えることなく、ＭＯＳ　ＦＥＴの漏れ電流の増大や耐圧低下を防止できる半導体集積回路の製造方法を実現する。
【構成】　ＭＯＳ　ＦＥＴを形成していく工程の中で、不純物を基板１に注入し、熱拡散処理を行って拡散層を形成する工程の後に、多結晶シリコン膜３に不純物を拡散して導電性をもつゲート電極２０を形成する工程をもってくる。



【特許請求の範囲】

【請求項１】 多結晶シリコン膜に不純物を拡散して導電性をもつゲート電極を形成する第１の工程と、
不純物を基板に注入し、熱拡散処理を行って拡散層を形成する第２の工程と、を少なくとも有し、基板上にＭＯＳ ＦＥＴを形成する半導体集積回路の製造方法において、
前記第１の工程は前記第２の工程の後にくることを特徴とする半導体集積回路の製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、高耐圧のＭＯＳ ＦＥＴを作るための半導体集積回路の製造方法に関するものである。

【０００２】

【従来の技術】高耐圧のＭＯＳ ＦＥＴとしては、例えば、二重拡散型のＭＯＳ ＦＥＴ（以下、ＤＭＯＳとする）がある。ＤＭＯＳは、長時間で高温の熱拡散処理によって基板に深い拡散層を形成し、深い拡散層の中に浅い拡散層を作り込んだＭＯＳＦＥＴである。このように二重化された拡散層は、深い拡散層をゲート領域に、浅い拡散層をソース領域にそれぞれ割り当てる。

【０００３】図２は従来におけるＤＭＯＳの製造方法を示した工程図である。以下、図２の工程図に従って製造手順を説明する。

（１）図２（ａ）に示すように、低濃度の基板１（例えばN^-型の基板）上に絶縁膜２（例えば酸化膜）を形成する。

（２）図２（ｂ）に示すように、絶縁膜２上に多結晶シリコン膜３を形成し、さらに多結晶シリコン膜３に高濃度のリンを拡散する。

（３）多結晶シリコン膜３上にレジスト４を形成し、レジスト４をパターニングする。そして、図２（ｃ）に示すように、パターニングされたレジスト４をマスクとして多結晶シリコン膜３をエッチングし、ゲート電極５を形成する。

（４）レジスト４を除去し、さらに基板１上にレジスト６を形成する。そして、図２（ｄ）に示すようにレジスト６の一部を開口し、開口部からＰ型不純物を注入する。注入した不純物は、図の点線で示す部分である。

（５）図２（ｅ）に示すように、高温で長時間の熱拡散処理により非常に深いＰ型層７を形成する。このとき、Ｐ型層７はゲート電極５の下まで広がっている。

（６）基板１上にレジスト８を形成する。そして、図２（ｆ）に示すようにレジスト８の一部を開口し、開口部からＮ型不純物を注入する。注入した不純物は、図の点線で示す部分である。

（７）レジスト８を除去し、その後、図２（ｇ）に示すようにアニール処理（活性化）を行い、Ｎ型層９と１０を形成する。

（８）図２（ｈ）に示すように、基板１上に絶縁膜１１を形成し、この絶縁膜にエッチングを施して電極取り出し部１２を形成する。

（９）図２（ｉ）に示すように、金属電極１３～１５を形成する。Ｐ型層７、Ｎ型層９、Ｎ型層１０は、それぞれＭＯＳ ＦＥＴのゲート、ソース、ドレインを構成する。金属電極１３、１４、１５は、それぞれソース、ゲート、ドレインに接続されている。

以上の工程を経てＭＯＳ ＦＥＴが作られる。

【０００４】しかし、図２に示す従来例では次の問題点があった。この製造方法では、多結晶シリコン膜３中にリンを拡散した後に、Ｐ型層７を形成するために高温で長時間の熱拡散処理を行っている。このため、高温で長時間の熱拡散処理により多結晶シリコン膜３中にドープされたリンは結晶粒界に析出し、この粒界を通してシリコン原子の自己拡散を律速させる。これによりシリコンの結晶粒が成長する。このとき、多結晶シリコン膜３の下地の絶縁膜２にストレスを与え、その絶縁性を劣化させる場合があり、ＭＯＳ ＦＥＴの漏れ電流の増大や耐圧低下の原因となる。

【０００５】

【発明が解決しようとする課題】本発明は上述した問題点を解決するためになされたものであり、多結晶シリコン膜に不純物を拡散する工程を、深い拡散層を形成するための熱拡散処理の工程の後にもってくることにより、最終的に作られるＭＯＳ ＦＥＴの構造を変えることなく、ＭＯＳ ＦＥＴの漏れ電流の増大や耐圧低下を防止できる半導体集積回路の製造方法を実現することを目的とする。

【０００６】

【課題を解決するための手段】本発明は、多結晶シリコン膜に不純物を拡散して導電性をもつゲート電極を形成する第１の工程と、不純物を基板に注入し、熱拡散処理を行って拡散層を形成する第２の工程と、を少なくとも有し、基板上にＭＯＳ ＦＥＴを形成する半導体集積回路の製造方法において、前記第１の工程は前記第２の工程の後にくることを特徴とする半導体集積回路の製造方法である。

【０００７】

【作用】このような本発明では、ＭＯＳ ＦＥＴを形成していく工程の中で、不純物を基板に注入し、熱拡散処理を行って拡散層を形成する工程の後に、多結晶シリコン膜に不純物を拡散して導電性をもつゲート電極を形成する工程をもってくる。

【０００８】

【実施例】以下、図面を用いて本発明を説明する。図１は本発明にかかる方法の一実施例を示した工程図である。図１で図２と同一のものは同一符号を付ける。図１の工程図に従って製造手順を説明する。

（１）図１（ａ）に示すように、低濃度の基板１上に絶

縁膜２を形成する。

（２）図１（ｂ）に示すように、絶縁膜２上に多結晶シリコン膜３を形成する。本発明が従来例と異なるのは、この段階では多結晶シリコン膜３に高濃度のリンを拡散しないことである。

（３）多結晶シリコン膜３上にレジスト４を形成し、レジスト４をパターニングする。図１（ｃ）に示すように、パターニングされたレジスト４をマスクとして多結晶シリコン膜３をエッチングし、ゲート電極２０を形成する。このときのゲート電極２０は、リンがまだ拡散されていないため、導電性をもたない。

（４）レジスト４を除去し、さらに基板１上にレジスト６を形成する。そして、図１（ｄ）に示すようにレジスト６の一部を開口し、開口部からＰ型不純物を注入する。注入した不純物は、図の点線で示す部分である。

（５）図１（ｅ）に示すように、高温で長時間の熱拡散処理により非常に深いＰ型層７を形成する。このとき、Ｐ型層７はゲート電極２０の下まで広がっている。

（６）基板１上にレジスト８を形成する。そして、図１（ｆ）に示すようにレジスト８の一部を開口し、開口部からＮ型不純物を注入する。注入した不純物は、図の点線で示す部分である。

（７）レジスト８を除去した後、図１（ｇ）に示すようにリンを適性量だけ添加した低温酸化層２１を形成する。ここで、適性量とは、この工程の後で行うアニール処理で、リンがシリコン中に拡散されない程度に高濃度になった添加量である。これにより、ゲート電極２０が導電性をもつ。この段階まで至ったところで多結晶シリコン膜３に高濃度のリンを拡散している点が従来例と異なる。

（８）図１（ｈ）に示すようにアニール処理（活性化）を行い、Ｎ型層９と１０を形成する。

（８）図１（ｉ）に示すように、低温酸化層２１にエッチングを施して電極取り出し部２２を形成する。

（９）図１（ｊ）に示すように、金属電極１３～１５を形成する。Ｐ型層７、Ｎ型層９、Ｎ型層１０は、それぞれＭＯＳ　ＦＥＴのゲート、ソース、ドレインを構成する。金属電極１３、１４、１５は、それぞれソース、ゲート、ドレインに接続されている。

以上の工程を経てＭＯＳ　ＦＥＴが作られる。

【０００９】なお、実施例ではＤＭＯＳを製造する場合について説明したが、製造する半導体集積回路はＤＭＯＳに限らず、高温で長時間の熱拡散処理により非常に深い拡散層を形成する工程を経て製造される半導体集積回路であればよい。

【００１０】

【発明の効果】本発明によれば、導電性をもたない多結晶シリコン膜のゲート電極をとりあえず形成しておき、深い拡散層を形成するための熱拡散処理を行った後に、多結晶シリコン膜に不純物を拡散してゲート電極に導電性をもたせている。このため、深い拡散層を形成するための熱拡散処理の工程において多結晶シリコン膜中にドープされた不純物は結晶粒界に析出することがない。これによって、ＭＯＳ　ＦＥＴの漏れ電流の増大や耐圧低下を防止できる。また、本発明により最終的に作られるＭＯＳ　ＦＥＴは従来例の方法により作られるＭＯＳ　ＦＥＴと同じ構成である。以上のことから、本発明によれば、最終的に作られるＭＯＳ　ＦＥＴの構造を変えることなく、ＭＯＳ　ＦＥＴの漏れ電流の増大や耐圧低下を防止できる。

【図面の簡単な説明】

【図１】本発明にかかる方法の一実施例を示した工程図である。

【図２】従来におけるＤＭＯＳの製造方法を示した工程図である。

【符号の説明】

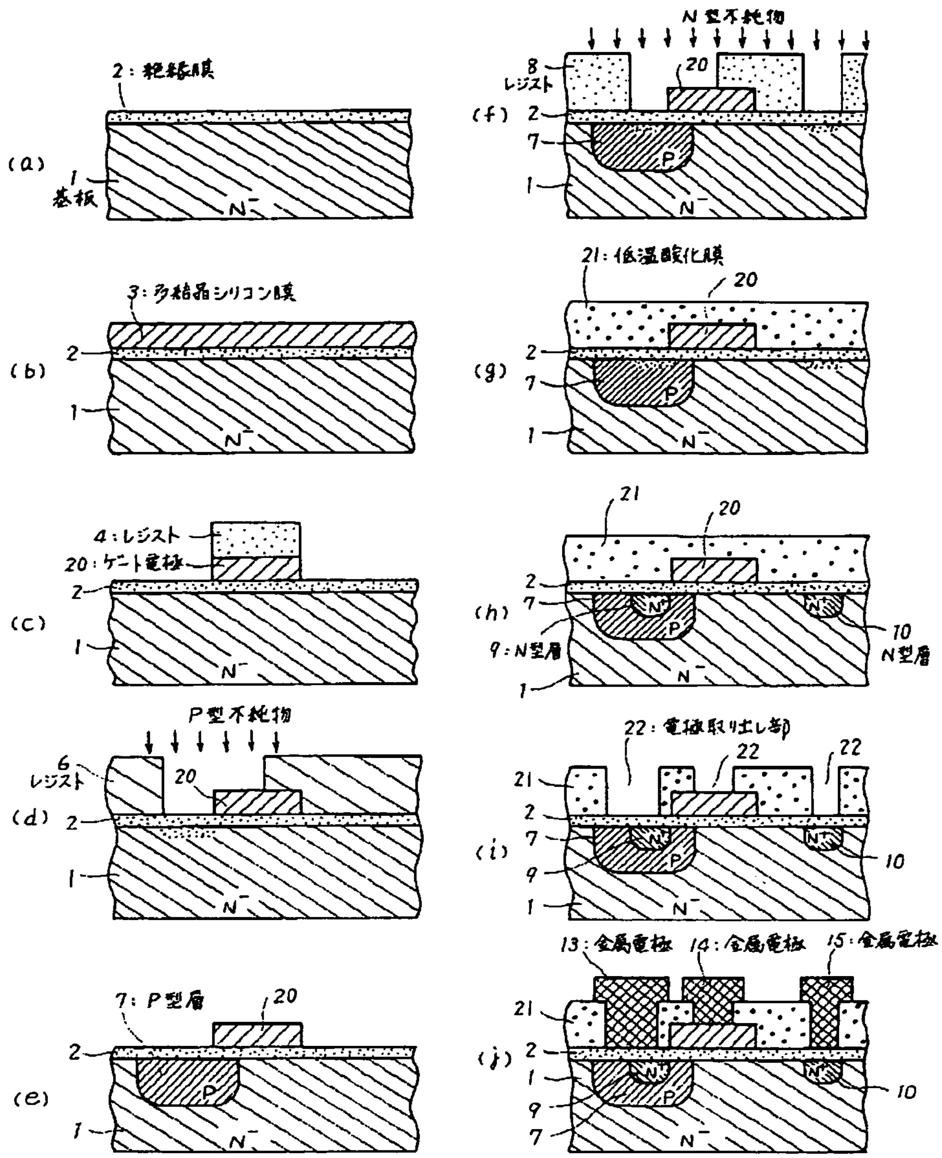
１　基板

３　多結晶シリコン膜

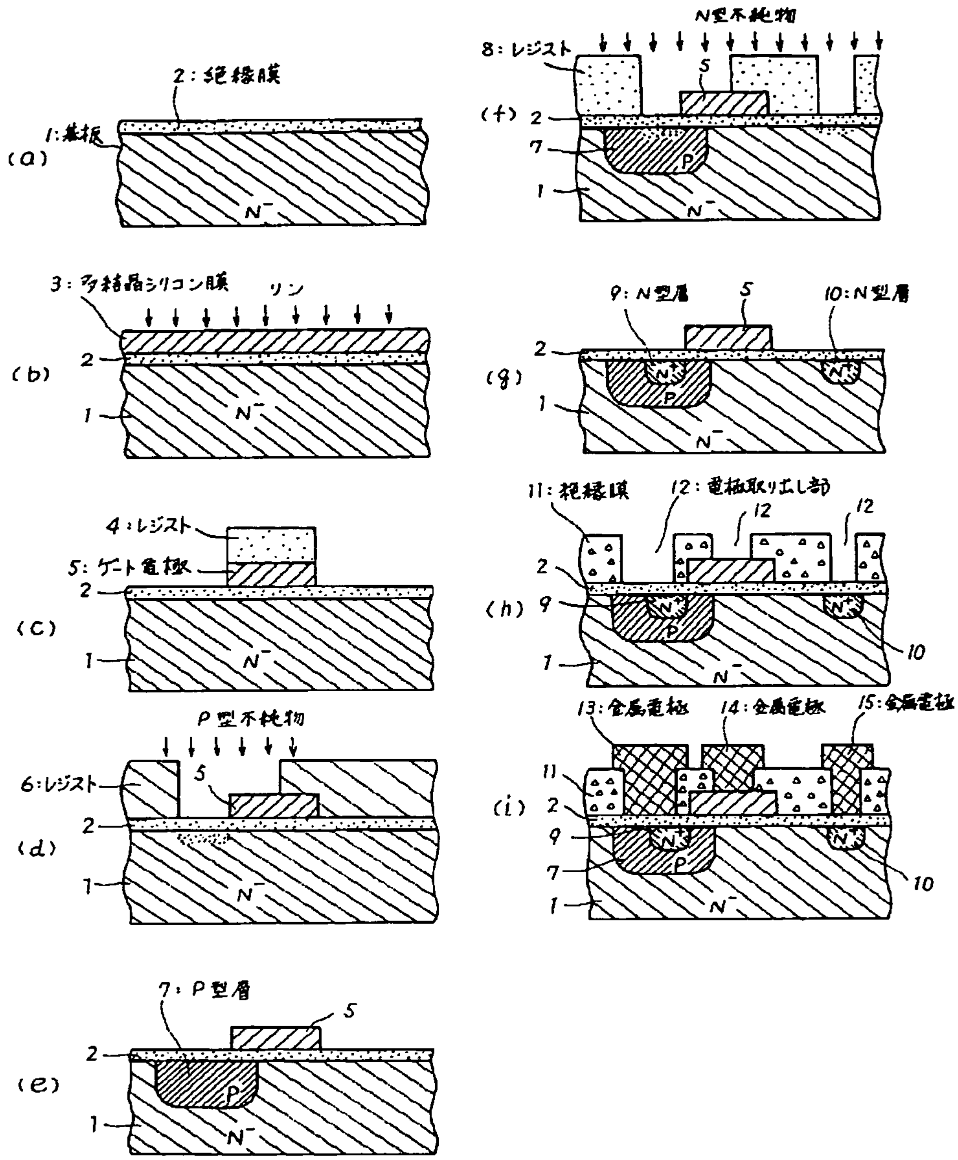
７　Ｐ型層

２０　ゲート電極

【図1】


2：絶縁膜
(a)
1
基板
N⁻
3：多結晶シリコン膜
2
(b)
1
4：レジスト
20：ゲート電極
(c)
P型不純物
6
レジスト
(d)
7：P型層
20
(e)
N型不純物
8
レジスト
(f)
7
21：低温酸化膜
(g)
21
(h)
9：N型層
10
N型層
22：電極取り出し部
22
(i)
9
13：金属電極
14：金属電極
15：金属電極
(j)

【図2】


(a)
2：絶縁膜
1：基板
N−
(b)
3：多結晶シリコン膜
リン
N−
(c)
4：レジスト
5：ゲート電極
N−
(d)
P型不純物
6：レジスト
N−
(e)
7：P型層
N−
(f)
N型不純物
8：レジスト
N−
(g)
9：N型層
10：N型層
N−
(h)
11：絶縁膜
12：電極取り出し部
N−
(i)
13：金属電極
14：金属電極
15：金属電極
N−